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Isthmian Canal Commission (U.S.)

Message from the President of the U.S.

Washington

1900

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PRELIMINARY REPORT

OF THE

ISTHMIAN CANAL COMMISSION,

NOVEMBER 30, 1900.

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MESSAGE

FROM THE

PRESIDENT OF THE UNITED STATES,

TRANSMITTING

A PRELIMINARY REPORT OF THE ISTHMIAN CANAL COMMISSION.

DECEMBER 4 1900.—Read, referred to the Committee on Interoceanic Canals, and ordered to be printed.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1900.

To the Senate and House of Representatives:

I transmit herewith, for the information of the Congress, a Preliminary Report of the Isthmian Canal Commission, dated November 30, 1900.

WILLIAM MCKINLEY.

EXECUTIVE MANSION,

December 4, 1900.

PRELIMINARY REPORT

OF THE

ISTHMIAN CANAL COMMISSION,

NOVEMBER 30, 1900.

Rear-Admiral JOHN G. WALKER,
United States Navy,
President.

Hon. SAMUEL PASCO.
Mr. GEORGE S. MORISON.
Lieut. Col. OSWALD H. ERNST,
Corps of Engineers, United States Army.
LEWIS M. HAUPT, C. E.
ALFRED NOBLE, C. E.
Col. PETER C. HAINS,
Corps of Engineers, United States Army
WILLIAM H. BURR, C. E.
Prof. EMORY R. JOHNSON.

Lieut. Commander SIDNEY A. STAUNTON,
United States Navy,
Secretary.

DEPARTMENT OF STATE,
ISTHMIAN CANAL COMMISSION,
Washington, D. C., November 30, 1900.

The PRESIDENT OF THE UNITED STATES.

SIR: It has been found impracticable to complete the work of the Isthmian Canal Commission and prepare a full report upon the investigation it was required to make in time for its presentation before Congress convenes in December.

The task intrusted to it was of great magnitude. It required exploration, examination, and research in distant countries to collect the data and information upon which to base its conclusions; the arrangement, tabulation, and study of these data, the determination of the best route for a canal at each locality, and of any variations necessary in former projects, the approval or change of sites for dams, locks, and other auxiliary works, the making of estimates, the preparation of plans, maps, and profiles—all demanded care and diligence and consumed much time. The parties employed in the field work have been returning to the United States, as the duties assigned to them have been completed, but some of them are still in Nicaragua and Panama and have not yet finished their labors. Until their return and the results they bring with them have been digested the task of the Commission can not be completed.

But the work has been sufficiently advanced to make it practicable to answer the interrogatories suggested by the law and the instructions given thereunder with reasonable accuracy, as the results of the unfinished work, though important for the development of certain details, are not likely to affect seriously the approximate estimates which have been prepared.

It has therefore been deemed best to report the progress that has been made and the conclusions which have been reached, and thus avoid the delay that a postponement might cause in the inauguration of the work which the legislation, under which the Commission is acting, was designed to promote.

Such a report is now submitted and, as soon as practicable, it will be followed by a later and final one containing a complete and detailed account of the entire work of the Commission along all of the lines of investigation it was directed to follow, with maps, plans, and profiles, and the topographic, hydrographic, and other data which have been collected and used in making its estimates and reaching its conclusions.

Purpose of the investigation.

The purpose of the investigation, undertaken in compliance with the law under which the Commission is acting, was to determine the most feasible and practicable route across the American isthmus for a maritime canal between the Atlantic and Pacific oceans, together with the cost of constructing the same and placing it under the control, management, and ownership of the United States.

The duty of aiding the President in the necessary examinations and ascertainments was entrusted to this Commission, and in the performance of this duty its members have endeavored to carry out the intent of the law and the instructions received through the Secretary of State.

The Commissioners were appointed on the 10th day of June, 1899, and qualified without delay.

Organization of the Commission.

The first meeting was held in the city of Washington on the 15th day of June, 1899, and Rear-Admiral John G. Walker was unanimously chosen as president, and at a subsequent meeting, held on the 6th day of July, Lieut. Commander Sidney A. Staunton, of the United States Navy, was chosen as secretary.

The work of the Commission was divided among five committees, with the understanding that they were to report their results and conclusions, with the evidence they had collected to the Commission for its consideration and action. These Committees were severally authorized to enter upon the investigation of the following subjects:

The Nicaragua route.

The Panama route.

Other possible routes.

The industrial, commercial, and military value of an interoceanic canal.

Rights, privileges, and franchises.

At the first meeting after their appointment, in obedience to a resolution of the Commission, each of these committees submitted an outline of a scheme for the investigation which formed its special work, and they have followed the general lines indicated in these plans.

Working parties sent to Nicaragua, Panama, and Darien.

The examination of the different proposed canal routes, and careful explorations to determine whether other routes exist presenting advantages for an interoceanic canal superior to those found at Nicaragua and Panama were at once set on foot.

A chief engineer was appointed to take charge in the field of each of the investigations to be made under the direction of the three committees charged with these duties. Working parties were sent into Nicaragua, Panama, and the Darien country under assistants appointed upon the recommendation of the chief engineer to collect such information and data as would serve as a safe basis for correct conclusions as to the practicability of the different routes, and an approximate estimate of the cost of each that was deemed feasible.

Instructions.

The general tenor of the instructions given to the parties sent to Nicaragua and Panama was to verify the examinations previously made, so as to determine the accuracy of former estimates and findings; to develop the canal lines by borings, so as to ascertain the nature of subsurface material; to lay out the center line upon the ground where it had not already been done; to survey the locations for locks and dams, using the diamond drill to determine the character of the underlying rock; to continue and extend the observations of rainfall and stream flow and of the lake fluctuation in Nicaragua; to ascertain the supply of materials for locks, breakwaters, embankments, and other auxiliary works, and to make careful surveys of the different harbors with a view to their improvement. The Darien country was to be explored from the Panama region to the Atrato River on the Atlantic and Pacific sides; the crest line of the dividing mountain range was to be carefully examined for the discovery of any existing gap or depression sufficiently low for canal purposes; former proposed routes were to be surveyed so as to develop their character and features, and the topography, hydrology, and meteorology of the country were to be carefully studied.

In all 31 working parties were organized and sent into the field, 20 into Nicaragua with about one hundred and fifty engineers and assistants, 5 into Panama with about 20 engineers and assistants, and 6 into the Darien country with about fifty engineers and assistants, making in all a force of about two hundred and twenty sent from the United States, the number varying a little from time to time, besides about six hundred laborers, boatmen, and other workmen employed in the different countries, a total of more than eight hundred.

Study of canal routes.

Meanwhile the members of the commission were devoting much time to a study of the different canal routes and an examination of the results of former surveys and explorations of the entire American isthmus. The reports and other writings upon the Nicaragua route afforded much information, but there were no similar advantages at hand for familiarizing themselves with the details of the Panama route. It was ascertained, however, that there were ample engineering and geographical data in possession of the New Panama Canal Company in Paris, and its officers offered to

open to the commission its records, plans, maps, profiles, and the results of the different surveys of the isthmian country made from time to time, if its members would visit that city. It was determined to improve this opportunity, and the commission left New York on the 9th day of August and returned on the 29th day of September. Most of this time was spent in Paris, where daily sessions were held at the offices of the company, when the officers could be present, and with the assistance of the director-general, the chief engineer, and other officials, the visiting commissioners made a thorough study of all the details of the Panama Canal scheme from its inception, including its economic, historical, and legal, as well as its engineering aspects.

Kiel Canal.

From Paris they went to Kiel, Germany, and passed through the canal there in company with its principal officers and engineers, with whose assistance they obtained much valuable data relating to canal construction. In like manner

North Sea Canal.

they examined the North Sea Canal in Holland, passing through it from Amsterdam to the North Sea. Subsequently they proceeded to England, where they inspected

Manchester Canal.

the Manchester Canal from that city to its outlet into the River Mersey, near Liverpool, and afterwards devoted a day to the examination of the Liverpool docks.

At all these places, in addition to the oral information which was freely given, the officers in charge gave the commission valuable printed data, maps, and drawings for further study. All the information thus collected at these different places, and full printed and written details of the Panama Canal scheme sent from Paris since the return of the commissioners, have been considered and utilized by the commission during the progress of its work.

Visit to Central and South America.

The general plan of investigation determined upon included a personal examination of the different canal routes upon the American isthmus and a visit to the capital cities of the countries where they are located, to ascertain the feeling and sentiment of the President and the people in each Republic with reference to the occupation of its territory for the construction of a canal to be under the control, management, and ownership of the United States.

Nicaragua.

To accomplish these purposes the commission sailed from New York for Greytown on the 6th day of January last and returned on the 3d day of April. The time from January 19 to February 27 was spent in Nicaragua. The party examined Greytown Harbor, the adjacent coast line from the mouth of the San Juan to the Indio, the work and plant left by the Maritime Canal Company, and the different outlets of the San Juan River. Thence it proceeded up the river in steamboats to Lake Nicaragua, changing from vessel to vessel whenever the state of the water and

the rapids in the channel made it necessary. Detours were made so as to inspect the sites considered suitable for locks and dams and other important points along and near the line of the canal where it did not follow the river. These detours were made in small boats and canoes and often on foot. The lake was then crossed and the canal line and adjacent country were traversed from the western shore to the terminus at Brito on the Pacific. The party traveled on horseback and sometimes on foot, making examinations of the same character as those made east of the lake. The camps of the working parties were visited all along the line, their work was carefully inspected, the results studied, and written instructions left as to the manner in which it should be continued.

Results accomplished by the Maratime Canal Company.

During the investigations upon the canal line the work accomplished by the Maritime Canal Company, in addition to the surveys and borings, the preparation of maps, plans, and profiles, and other preliminary operations, was examined and inspected. It was found that a railroad had been constructed and partly equipped from Greytown to the headquarters on the beach at La Fé and for about twelve miles westward along its line from the opening of the canal into the harbor, also a telegraph line from the same point to Castillo, covering with its loops about 60 miles. The excavation of the canal had been commenced and carried forward for about three-quarters of a mile to a depth of 16½ feet, and varying in width from 150 to 230 feet. In an effort to improve the entrance to the harbor in use at the time a jetty 42 feet wide had been constructed to a distance of 947 feet seaward and filled with brush mattresses, rock, and hydraulic-cement concrete. Upon it was a railway track which had been used in its construction.

In addition to this a clearing 486 feet wide had been made for a distance of 10 miles along the canal line at the eastern end, and the forest growth had been removed for nearly the same distance at the western end; a number of temporary frame buildings had been constructed for quarters, storehouses, workshops, and hospitals on the shore of the Caribbean near La Fé, and near the entrance to the canal. The company had also purchased several dredges; five of these and a number of steel boats, launches, tugs, lighters, and other property are still lying in the lagoon near Greytown and along the adjacent shores in an exposed and neglected condition. The railroad embankment, which was built for a greater part of the distance over a swamp, still remains, and is in good condition. The ties are mostly rotten but the rails were, at the time of the commission's visit, in good order.

The short section of partially constructed canal is perhaps in as good shape to-day as it was when the work was stopped. The buildings are all rotten, and may be considered as valueless for any future operations. The dredges, boats, etc., are worthless. Some of the

tools and machinery in store might be made use of, but they have little, if any, value now. It is understood that all this property has been declared forfeited to the Nicaraguan Government under the terms of the concession. The railroad embankment and the piece of canal constitute all that would be of any value in future operations, and the latter item has value only for river diversion in case the canal terminates in the Greytown Lagoon.

Visit to Managua.

After the examination of the entire canal line from Greytown to Brito, the commission journeyed from Rivas, its headquarters west of the lake, by steamboat and railway to Managua, the capital, where the President and other leading officials and citizens received the party with a cordial welcome and manifested great interest in the project of establishing an interoceanic communication through Nicaragua rather than at any other location. The occupation of their territory by the United States for this purpose did not seem to be regarded as a serious obstacle, provided the sovereignty of the Republic was respected and maintained.

Panama.

After leaving Managua the party went by rail to Corinto and took a steamer for Panama, where it arrived on the 3d day of March. Two houses built by the French company at Colon were placed at the disposition of the commission, and its members, after a short delay at Panama, crossed the Isthmus and made their headquarters at the Atlantic terminus of the canal route during their stay in the country. From this place daily trips were made to different points on the railway from which the canal line could be reached, and the same thorough inspection of the whole work and the harbors at each terminus was made as in Nicaragua. The examination was extended to the upper waters of the Chagres in the Alhajuela region, and the entire river was traversed in canoes from there to the point near its mouth where it leaves the canal line.

The commission found a large force of workmen and laborers engaged upon the canal line, about two thousand in number, according to the statements of the officers of the Panama Canal Company, who were superintending the work upon the Isthmus. Most of these were engaged at and near the deep cut in the Culebra region, excavating the earth and rock and removing the excavated materials in dump cars to the spoil banks. Here at the divide the greatest results have been accomplished, and the French engineers estimate that the cut which has been made has an average depth of more than 160 feet. The canal had been opened by the old French company at the Atlantic end, in the Bay of Limon, near Colon, to a distance of about thirteen miles. The depth as excavated was from about sixteen to twenty-nine and one-half feet, but it had been abandoned for a long time and had silted up from the Chagres River and other water courses, so that in places it could be used only by boats or launches of light draft. There are

other excavations at different places along the route, and an opening has been made at the Pacific end for about 3 miles inland from the shore of Panama Bay to a depth of from about 6 to about 26 feet, varying in different localities. In the bay a channel has been dredged to deep water at the anchorage near the island of Naos.

The work done in the Culebra region and at the two ends of the canal, and some in other sections, can be utilized in executing the plan adopted by the commission. Its value in this respect has been considered and the approximate estimate of the additional cost of the canal, if it had not been accomplished, based upon the unit prices which have been used in other estimates, will be given in another part of this report.

At Colon and at different points along the line there are storehouses, covered sheds, and other buildings filled with locomotives, excavators, cars, dredges, and an immense amount of other machines, implements, tools, and supplies of various kinds, all purchased for canal purposes, besides the locomotives, cars, steam shovels, and other machines and tools in actual use in the work now going on. Much of this property is ill adapted to American methods of work, and all of it is now from thirteen to twenty years old, during which period the improvements in this class of machinery have been such that contractors would generally find it to their advantage to buy entirely new machinery of modern pattern rather than attempt to use this of an older class, even if given to them free and in good order. The locomotives, rails, and cars may be of some service, but their value is doubtful; the locomotives are much lighter than is desirable for economical service, the rails are of a pattern ill fitted to rough use, and the cars have narrow tread wheels. The cars are the best part of the whole outfit, and it is quite likely that they would be used; but it has seemed to the commission that no value should be given to the plant now on the Isthmus, although its owners may realize something by the sale of portions of it to contractors, if they consider that they can use it to advantage.

The existence of the Panama Railroad is, however, a very important factor, as it supplies a service railroad for the entire length of the canal. On the basis of $75,000 a mile, this railroad would be worth $3,500,000, which is half the face value of its capital stock. In view of its good condition and its valuable termini, it should not be estimated for purposes of canal construction at less than $7,000,000, the par value of its stock.

Costa Rica. Visit to San José.

The investigation was closed on the 18th day of March, and a majority of the commission then proceeded to San José, the capital of Costa Rica, where they had several interviews with President Iglesias and met the members of his cabinet and of the higher courts and other representative men of the Republic. They were treated with great cordiality

and consideration, as they had been at Managua, and found a public sentiment in favor of a maritime canal to be constructed by the United States similar to that which was manifested in Nicaragua.

It is proper to add that the commission was greatly aided in its work at San José by Mr. Rufus A. Lane, secretary of legation, chargé d'affaires in the absence of Mr. Merry, the United States minister, and at Managua by Mr. Chester Donaldson, the United States consul there. The members of the commission are also indebted to these gentlemen for many personal courtesies.

Colombia.

The disturbed condition of Colombia and the interruption of travel on account of a revolution then in active progress made it impracticable to proceed to Bogota, the capital, so as to call upon the president and ascertain the views of the Government and people of the Republic with reference to the occupation of their territory by the United States in case the Panama route should be regarded as the most practicable and desirable.

Darien.

Mr. George S. Morison, who was chairman of the committee having in charge the investigation for other possible routes, left the party at Colon on the 16th of March to ascertain the progress of the explorations in the Darien country on the Atlantic side, with full authority to direct the further prosecution of the work and make any changes in the working parties and their supervision that he might deem advisable.

He left late at night on the U. S. S. *Scorpion*, commanded by Lieut. Commander Nathan Sargent, and next morning reached Mandinga Harbor, in San Blas Bay, in the vicinity of which the nearest of the working parties were encamped. He visited those operating from this base and then sailed for Caledonia Bay. He there received reports of what had been accomplished, gave further instructions to those in charge of the explorations, and then proceeded to Cartagena, where some of the engineers and assistants were awaiting orders. He made some changes in the organization of the exploring parties, prepared a scheme for the conduct of the general operation of the work on the Pacific as well as the Atlantic side, and returned to Caledonia Bay and thence to San Blas Bay. On the return trip the different camps were visited again, and instructions were given to those in charge of the investigation at the different points, in accordance with the plan he had prepared. The *Scorpion* kept close in shore and the mountain ridge was carefully examined. The trip was completed on the 7th of April, and on the 11th he left Colon for New York.

Study of dimensions.

After the commission returned to the United States much attention was given to the determination of the proper dimensions for a maritime canal under existing conditions, and the unit prices to be used in making the estimates for the cost of construction at each of the proposed routes mentioned in

the law. The dimensions of the largest sized ocean-going vessels now in use were ascertained, and correspondence was opened with leading ship builders and directors of steamship lines, at home and abroad, to ascertain the size of those now on the stocks and whether the enlargement which has been going on for many years is likely to continue, and, if so, to what extent, during the next twelve or fifteen years. The results were considered in connection with other information in reaching the conclusions upon which the estimates in this report are based, and the unit prices which were agreed upon have been applied to these dimensions.

Dimensions.

A depth of 35 feet at mean low water and a bottom width of 150 feet were adopted as standard dimensions for a canal in excavation by each route. This width is for straight sections; on curves with a radius of less than 12,000 feet it is increased at the rate of 1 foot for each 200 feet reduction of radius, the width thus becoming 180 feet on a curve of 6,000 feet radius. In open channels, excavated within the shallow limits of harbors or lakes, the bottom width is increased to 200 feet, in the San Juan River to 250, and in the excavated portions of Lake Nicaragua to 300 feet. In the artificial harbors of Colon, Greytown, and Brito it is made 500 feet. These dimensions are larger than those proposed for any previous isthmian canal scheme. While they may seem excessive to-day, the canal is not likely to be opened within ten years, during which time the increase in marine dimensions which has been going on for many years is likely to continue.

The isthmian canal, except in the two maritime sections, will be a fresh-water canal. The draft of ocean steamers is based on salt water weighing 64 pounds per cubic foot. Some large freight steamers now draw 32 feet at sea, and would draw nearly 33 feet in fresh water. If the heaviest class of freight steamers is to use the isthmian canal, 35 feet is the least depth that should be adopted.

A width of 150 feet will allow all but the very largest ships to pass each other in the excavated portions of the canal; if two such large ships meet, one will have to take the bank while the other goes by; smaller ships will pass each other and larger ships without stopping.

In soft earth or sand the estimates are based on taking out the canal with side slopes of 1 on 3 below water and 1 on 2 above water. In firm earth they are based on side slopes of 2 on 3 below a berme 10 feet wide 6 feet below water, and 1 on 1 above such berme. In rock they are based on vertical sides from the bottom to a berme 5 feet above water with slopes of 4 on 1 in hard rock and 2 on 1 in soft rock above such berme, the berme being of such width that the extended slopes would intersect the bottom of the canal at the foot of the vertical sides. In certain special locations, like the Culebra cut on the Panama route, retaining walls are provided, these walls taking the place of the vertical sides of rock cuts.

The largest merchant ship now afloat is 704 feet long and 68 feet beam. Ships of larger displacement are now building, and freight steamers with a beam of about 75 feet may soon be common; four such ships are now on the stocks. Battle ships have a greater beam than other ocean-going vessels of like displacement; none now in the United States Navy exceeds this measurement, but designs have been prepared for some soon to be constructed with a beam of 76 feet 10 inches. These when completed will be of greater beam than any now afloat. These sizes have been used as a basis for determining the size of locks, the governing dimensions of which have been fixed at 740 feet long and 84 feet wide, in the clear, with a depth of 35 feet over the miter sills. The length, width, and depth are each 2 feet greater than those adopted by the French company for Panama. Twin locks are provided for in every case.

In special cases some of these dimensions might be changed in construction, but they have been followed in these estimates in order to make a comparison between the different routes.

Unit prices.

Unit prices have been fixed by agreement of all the members of the commission, on the principle that whatever differences of opinion or circumstances may exist, they are not enough to interfere with a fair and close comparison of the different routes. These prices are as follows:

Removal of hard rock	per cubic yard	$1.15
Removal of soft rock	do	.80
Removal of rock under water	do	4.75
Removal of earth not handled by dredge	do	.45
Removal of dredged material	do	.20
Embankments and back filling	do	.60
Rock in jetty construction	do	2.50
Stone pitching, including necessary backing, per square yard		2.00
Clearing and grubbing, Nicaragua swamp sections	per acre	200.00
Other clearing and grubbing	do	100.00
Concrete in place	per cubic yard	8.00
Metal in locks, exclusive of machinery	per pound	.075
Timber in locks	per M B. M.	100.00
Operating machinery, each lock chamber		50,000.00
Power plant, each group of locks		100,000.00
Single track railroad, complete with equipment	per mile	75,000.00

Contingencies, etc.

It was determined to add 20 per cent to the estimates of the cost of construction to cover expenses that will be incurred for engineering, police, sanitation, and general contingencies. The prices are based on efficient organization and thorough equipment, with the understanding that while the work would be vigorously handled it would not be so driven as to call for unnecessary duplication of machinery. The cost of the equipment and plant will be large, but it will be distributed over a very large work.

Other possible routes.

The well-known geographic conditions at Tehuantepec and between the Nicaragua and Panama canal routes made it unnecessary to explore those parts of the American isthmus for other possible locations for an interoceanic canal, and the commission limited its investigations to what is generally known as the Darien country, extending from Panama to the Atrato River.

For about 80 miles the width of the Isthmus in this region does not exceed 40 miles, except at one or two headlands which project beyond the general line of the coast. The narrowest point is at San Blas, where the distance from Mandinga Harbor to the shore of Panama Bay is only 31 miles, 2 miles less than from the head of the bay of Limon, at Colon, to the mouth of the Bernadino. On the eastern side of Panama Bay, about 100 miles from Panama, an estuary known as San Miguel Bay extends into the interior to within 33 miles of Caledonia Bay, on the Atlantic side. This bay of San Miguel, on the Pacific, and San Blas and Caledonia bays, on the Atlantic side, afford excellent harbors and canal approaches. Between Panama and San Blas the ridge of the Cordilleras crosses from the Pacific to the Atlantic side and continues there to the mouth of the Atrato River.

As the existence of practicable and feasible routes in this section depended upon the height and continuity of the divide, its crest was examined all along the line, with as much care and accuracy as was practicable under the conditions which existed, for the discovery of gaps and depressions, so as to ascertain whether any were sufficiently low for canal purposes, and measurements were made of those which promised the most favorable results.

The ridge was traced continuously on the ground from the head of the river Carti, a little east of Mandinga Harbor, in San Blas Bay, in latitude 9° 19′ N., longitude 78° 59′ W., to the head waters of the Chagres, and thence down the river to the Panama Railroad, a total distance of 24½ miles; also near Caledonia Bay from the Carreto summit, in latitude 8° 45′ N. and longitude 77° 38′ W., to the Sassardi summit, in latitude 8° 56′ N., longitude 77° 52′ W., a distance of 27½ miles. The lowest elevation in the former section was 956 feet, in the latter 683 feet. These results were obtained by actual leveling. Between these two sections from San Blas Bay to Caledonia Bay, a distance of 81 miles in an air line, and from Caledonia Bay southward to the Atrato River, the examination was made from the sea, the elevations of the higher peaks, as well as the gaps and their distances,

being determined by observations made with two sextants. The results showed that there was no probability of any suitable depression within these limits.

In addition to these investigations, a survey was made from San Miguel Bay, on the Pacific side, up the Chucunaque and Chucurti (Sucubti) rivers, which was almost though not quite connected with the work done near Caledonia Bay. After the results of the general exploration were determined the examination of other possible routes was limited to those sections where the isthmus was narrowest, where the coast lines offered good harbors, and the indications along the divide were the most promising. These conditions were found near San Blas Bay and Caledonia Bay. East of San Miguel Bay the isthmus widens, and no route can be expected there less than a hundred miles in length.

San Blas.

The San Blas route extends from the bay of that name to the mouth of the Bayano, on the Pacific; it has been advocated as the shortest line between the two oceans, which is true. The most complete plan developed involves a tunnel at least 7 miles long. While not necessarily impracticable, such a tunnel would be very objectionable and would render the line inferior either to the Panama or the Nicaragua location.

Caledonia Bay.

The distance from Caledonia Bay to tide water on the Savana River is about 30 miles in a straight line. Studies have been made of three lines across the divide, all of them striking the same point on the Savana river, near the mouth of the Lara, the approach upon the Atlantic side being through the three valleys of the Caledonia, the Aglaseniqua, and the Sassardi. The distance from Caledonia Bay to the mouth of the Lara varies from 32 miles by the Sassardi route to 36 by the Caledonia route. The Sassardi route has not, however, been explored through its whole length, and it is possible that an actual survey would make it as long as the Caledonia route. Each line would require a tunnel. If the Sassardi route were taken, the length of this tunnel, assuming an open cut to be used to the depth of 400 feet, would be about 1.6 miles. On either of the other two the tunnel would be about 2 miles longer, while the approaches on the south side would be much heavier.

These surveys indicate that the Sassardi route is probably the best of the three for a sea-level canal. The indication can not be regarded as conclusive, because a thorough survey and development of the subsurface material might show insuperable difficulties, which would be more likely to exist in the tunnel than elsewhere. The cost of a canal upon this line would be excessive and the tunnel more objectionable to navigation than the locks on the other routes.

Caledonia Bay is virtually tideless. San Miguel Bay has a tidal range of 20 feet or more. This heavy tide causes currents in the

Savana River of sufficient force to be a serious menace to navigation, and it would be necessary to build a tide lock near the mouth of the Savana. The distance from the mouth of the Lara to the tide-lock site is about 14 miles, the upper portion of which is in a narrow river which would require enlargement for a canal. This makes the total length of canal navigation from Caledonia Bay to the tide lock about 50 miles.

The result of all these examinations shows that there is no probability of the existence of any practicable canal location between Panama and the mouth of the Atrato River, except by the adoption of a tunnel line, and there seems to be no reason for further field work except in the interest of geography.

The conditions existing in Darien, along the Atlantic coast and adjacent thereto, rendered it impracticable to make the necessary explorations and surveys there without the aid of a Government vessel. There are no ports or lines of travel or communication nearer than Cartagena and Colon. It is inhabited by the San Blas Indians, who, though generally peaceable, are jealous of strangers and exclude them from their country. Though nominally under the sovereignty of Colombia, they recognize no rule but their tribal organization. A proper understanding with their chiefs was therefore necessary before the engineers and working parties of the commission could gain ready admission into their territory. Under these circumstances the Secretary of the Navy assigned to the service of the commission the U. S. S. *Scorpion*, under the command of Lieut. Commander Nathan Sargent, who was authorized to render such assistance as he properly could in the investigations to be made in this region.

A large part of the responsibility of the expedition rested upon this officer, and he displayed excellent administrative judgment and capacity in the discharge of his duties. After landing the working parties where they were to encamp, he established amicable relations with the Indians, under which the work was carried on in security, and the chiefs were satisfied that their people would be protected from any encroachment upon their rights. Much of the success that was achieved is due to his energy, fairness, and resolution.

Nicaragua route.

The following is the result of the investigation at Nicaragua, with a description of the route and estimate of cost:

On the easterly side of the isthmus the location of the Nicaragua route lies generally up the course of the San Juan River for 100 miles from the Caribbean Sea to Lake Nicaragua, about 105 feet above it; thence across the lake, about 70 miles, to a point on its western shore, and running 17 miles from there through the continental divide, about 44 feet above the lake, down to the ocean at Brito, the Pacific terminus. The lake is a large body of water, sufficient to furnish a practically unlimited supply to the canal. The San Juan River is

navigable for vessels of light draft, and affords a location for a masonry dam about 50 miles from the sea, by means of which the level of the lake is extended to the same point.

Lake Nicaragua.

The route lies mainly in the Republic of Nicaragua, but Costa Rica has the right of navigation in the San Juan River below Castillo, a part of which is included in the canal project. Lake Nicaragua, which forms a part of the summit level, is about 100 miles long and 45 miles wide, distant only about 12 to 30 miles from the Pacific, the longer axis being nearly parallel to the coast. The intervening territory is generally hilly, the range forming part of the continental divide.

The lake discharges through the San Juan River into the Caribbean Sea near Greytown. For the upper half of its course the San Juan flows through a hilly country, with a tortuous channel. Neither the river itself nor any of its tributaries in this section carries much sediment, and a slack-water navigation by means of locks and dams is practicable.

At the foot of this stretch the river receives from its right bank the San Carlos, its most important affluent, which discharges into it large quantities of sand. Below the confluence of these streams a slack-water navigation is not deemed practicable, and the canal route therefore leaves the river a short distance above the mouth of the tributary and is to be excavated thence to the Caribbean, a distance of about 50 miles. Below the mouth of the San Carlos swampy bottom lands appear, crossed by several high ridges, which, starting from the flanking mountain ranges, end on the bank of the river. The easternmost of these high ridges is about 26 miles from the seacoast, but for some distance beyond low hills and groups of hills appear in places. The region is generally swampy, the surface of the ground is but little above sea level, and the soft mud sometimes extends to a depth of 30 feet or more. A narrow strip along the coast is of sand, the gradual accretion from material brought down by the rivers from Costa Rican mountains and distributed along the coast by the waves and currents of the sea.

The project for a canal on this route follows essentially the lines laid down by the Nicaragua Canal Commission in its report, 1897–1899. It begins at the Caribbean Sea, near Greytown, follows a southwesterly course, passing to the northward of the Silico Hills, thence in a more southerly course until it reaches a point about a mile and a quarter from the San Juan River; thence it follows along the left bank of that stream, keeping a safe distance from it, until it enters the San Juan River at a point about 2 miles above the mouth of the San Carlos. The line then follows the upper San Juan to Fort San Carlos, where it enters Lake Nicaragua. After crossing the lake in a northwesterly direction to the mouth of the Rio Las Lajas, it follows the valley of

that stream a short distance and crosses the continental divide into the valley of the Rio Grande on essentially the route suggested by Colonel Childs in 1850, which follows the valley of the Rio Grande to Brito, the Pacific terminus of the canal.

The following is a table of distances on the Nicaragua route:

Number of miles of canal proper	67.33
Number of miles of river improved	27.96
Number of miles of river not requiring improvement	17.26
Number of miles of lake channel 300 feet wide	22.19
Number of miles of lake not requiring improvement	48.74
Number of miles of harbors and entrances to same	3.05
Total number of miles from ocean to ocean, measured from the 6-fathom curves	186.53

Summit level.

The summit level is to be reached from the Atlantic side by five locks, the first having a lift of 36½ feet and the other four having a uniform lift of 18½ feet each, except the lock at the summit, the lift of which will vary with the level of the lake, being 12½ feet when the lake is at its lowest and 18½ feet when at its highest stage. From the Pacific side the summit will be reached by four locks of uniform lift of 28½ feet. The mean level of the two oceans is assumed to be the same. It is known that they are nearly so. The mean range of tides on the east side is about 1 foot, that on the west side is about 8 feet. Mean low tide, which is the level that determines the depth of excavation of the maritime sections, is therefore half a foot below mean sea level on the east side and 4 feet below mean sea level on the west side. The lift of the lock at the summit, however, will vary from 22½ to 28½ feet, according to the stage of the lake, and that at the Pacific end will vary from 20½ at high to 28½ feet at low tide.

Lake level.

Lake Nicaragua and that portion of the San Juan River from the lake to near Boca San Carlos, and that portion of the canal on the west side between the lake and Buen Retiro, will form the summit level. From the best data available it is believed that Lake Nicaragua varies in its level, under existing conditions, as much as about 13 feet. There is good reason for believing that it sometimes goes as high as 110 and sometimes as low as 97 feet. These extreme fluctuations, however, occur only at relatively remote intervals. In order to reduce the amount of this fluctuation it is proposed to build a dam in the San Juan River, above the mouth of the San Carlos, on the east end of the summit level, and another smaller dam on the west side near Buen Retiro, to regulate the lake level.

By means of these dams and regulating works the fluctuations of the lake level can be held within the limits of 6 feet, or from 104 feet to 110 feet above mean sea level. The summit will be excavated to the

full depth below the lower level. The data on which the solution of the problem of regulating the lake level rests are not as full as is necesssary for a rigid solution; but an approximate solution has been made, and it is believed that any errors which may exist are on the side of safety.

The salient engineering problems connected with the Nicaragua Canal project, briefly outlined, are as follows:

First. The construction of harbors at the termini of the canal.

Second. The excavation of the canal prism in the swamp sections between Greytown and the Florida Lagoon.

Third. The heavy cutting near Boca San Carlos and at Tamborcito.

Fourth. The construction of the large dam at or near Boca San Carlos in connection with the regulation of the summit level.

Fifth. The locks.

Greytown Harbor.

Some fifty years ago there was a good harbor at Greytown, the eastern terminus of the canal, with 30 feet of water at the anchorage and about the same depth in the entrance. The entrance to this harbor, where it then existed, has been obliterated, and the harbor itself is now a lagoon almost entirely inclosed, of restricted area, with only about half the depth of water in it that formerly existed. Vessels for Greytown are now compelled to anchor in the offing and discharge their cargoes on lighters which are taken into the lagoon across a bar having a depth of less than 6 feet of water. As the prevailing trade winds are strong and blow almost directly on this part of the coast, the construction of a harbor at this terminus of the canal becomes necessary in the early stages of the work, as well as for use after the canal is completed.

It is proposed to construct such a harbor, of sufficient area to accommodate vessels using the canal, by excavation, with an entrance having a least depth of 35 feet and a bottom width of 500 feet by the construction of two jetties springing from the shore line near Harbor Head, built of loose stone, to a height of 6 feet above mean high tide; the hearting of each jetty to be composed of small and the outer portion of large stone, not easily moved by the waves. It is not expected, however, that the construction of the jetties alone will form an entrance. Dredging will also be necessary, and its maintenance may require an extension of the jetties or dredging, or both.

Brito Harbor.

The western terminus of the canal will be near Brito. Here, as at Greytown, there is no harbor, and an artificial one must be constructed. The same general engineering principles will guide in its construction. The width and depth of the entrance will be the same. The sand movement on the western coast, however, is slight as compared with that in the vicinity of Greytown. The prevailing winds on this side are offshore and destructive storms seldom visit this part of the coast. The cost of maintenance,

therefore, of the harbor on the west side will be less than that of one on the east side at Greytown.

Swamp section between Greytown and Florida Lagoon.

For a part of the distance between Greytown and the Florida Lagoon the canal line passes over swampy sections, where the material is too soft to support the embankments necessary to keep out the floods of the San Juan and to maintain the canal level itself. Protecting embankments are therefore to be constructed over these sections. These embankments are to be located as far as practicable on the firm land composing the neighboring hills. In places, however, they cross ground which is soft to a considerable depth. Waste ways are provided on the embankment lines to dispose of flood water in the protected areas.

Heavy cuts near Boca San Carlos and Tamborcito.

At two places near the Boca San Carlos dam site heavy cutting is encountered, the maximum depth for short distances being 218 and 170 feet, respectively; but the deepest cut of all is at Tamborcito, about 26 miles from Greytown. Here the high ground north of the canal approaches so close to the river that a cut through it becomes imperative. The ridge is narrow, however, the width at the top being only a few feet and at the level of the water in the canal less than 3,000 feet; but the extreme depth of the cut is 297 feet. The borings show that it is nearly all hard rock. The less heavy cuts will also be in firm ground, but the exact character of the material can not be stated until the borings now in progress have been completed.

San Carlos Dam.

The most difficult engineering work in connection with the Nicaragua Canal project is the construction of a dam across the San Juan River to hold back the waters of the lake and enable its level to be regulated. It is of great importance that this dam should be located above the mouth of the San Carlos River, as the latter discharges at times as much as 100,000 cubic feet of water per second, carrying with it great quantities of sand.

The construction of the dam below the mouth of the San Carlos, even if an eligible site were found, would, in addition to other difficulties, involve contention with the combined powers of two rivers, the San Juan proper and the San Carlos, the discharge of which may at times reach 200,000 cubic feet per second. The Nicaragua Canal Commission made search for a dam site above the mouth of the San Carlos, in what is called the Agua Muerta (dead water). One was found at a place about 2 miles above the mouth of the San Carlos River. Several borings were made to determine the level of the rock. These indicated that good rock would be found at a maximum depth of about 14 feet below mean sea level. The borings, however, were not sufficient in number to determine with accuracy the topography of the rock, nor its exact character. The present commission has planned

three lines of borings, 100 feet apart, at the site of this dam, the borings being spaced 100 feet apart on each line. Hard rock for the foundation has been found, but in several places at a depth greater than the limited number of borings first taken indicated. The maximum depth to hard rock, as developed by the latest borings, is about 40 feet below sea level, or about 100 feet below low water in the river at the site, which will make it necessary to construct the foundation of this part of the dam by the pneumatic process. The dam in the deepest part will then have a height of about 150 feet.

As the pneumatic process is an expensive and slow one at best, this Commission has made search for an alternative site a few miles farther up the river, where the topographical and surface indications seemed to offer favorable results. One has been found which gives promise of a more satisfactory and less expensive solution of this problem, but the number of borings thus far taken is not sufficient to determine this with certainty. The estimates, therefore, are based on a dam at the site selected by the Nicaragua Canal Commission.

Locks. Lock No. 1, on the east side, will have a lift of 36½ feet, but it is founded on rock. The others on the east side have a lift of 18½ feet, and are to be located on foundations that are believed to be safe. All the locks on the west side are founded on rock.

Time. The time required to build the Nicaragua Canal hinges almost entirely on the time required for the construction of the Boca San Carlos dam. After a harbor has been opened at Greytown, and a railroad constructed, the way will be open to attack the work from a great many points at the same time, so that if ample funds are then available, the excavation of the prism of the canal ought to be completed in a comparatively short time if prosecuted with vigor. The construction of the dam, however, will be a costly and tedious operation. Eight years would probably be a reasonable estimate for the time of building this dam. At least two years will be consumed in preparatory work and in opening a harbor at Greytown, so that if work on the dam should be commenced immediately thereafter, the time required for completing the entire work would be about ten years.

Estimates. In order to properly classify the materials to be excavated on this route many borings were necessary. In some cases where they proved unsatisfactory, slight changes have been made in the alignment of the canal. The borings have not yet all been completed, and the classification of the material, therefore, is based, in part, on surface indications and judgment. Consequently, in the final estimates, the classification which will be made from the actual borings may cause some differences. These, however, it is believed, will not materially affect the amount of the estimates.

The following is the estimated cost of a canal on the Nicaragua route:

Eastern Division (from Greytown to Boca San Carlos dam)	$82,662,000
Middle Division (from Boca San Carlos dam to Las Lajas)	25,425,000
Western Division (from Las Lajas to Brito)	51,680,000
	159,767,000
98 miles of railroad	7,350,000
Total	167,117,000
Engineering, police, sanitation, and general contingencies	33,423,000
Aggregate	200,540,000

This estimate is for a canal suitable for navigation by the largest ships now in existence, and thus in accordance with the terms of the bill pending in Congress. It provides for a double system of locks, so that navigation can be maintained if one system be closed for repairs or renewals.

The estimate of cost is much in excess of any heretofore made on this route and arises chiefly from the increased dimensions of the canal, the double system of locks, the extra cost of the San Carlos dam, due to increased depth of rock, increased embankments, and the modification in a part of the line on the eastern division, which has been located by this Commission farther from the San Juan River in the interest of security.

While the project on which this estimate is based is the one recommended, a canal of smaller dimensions and reduced lockage facilities can be opened for navigation at considerably less cost. If a single lockage system only were first provided, so designed as to permit the construction ultimately of a second system, the first cost would be reduced $19,678,000. A further reduction of $16,949,000 could be made by narrowing the bottom width one-third in all the excavated channels in canal, river, and lake sections. With these reductions made the estimated cost would become $163,913,000. In such a canal the time for passage and the risks to ships would be materially greater than in the one recommended.

The following is the result of the investigation at Panama, with a description of the route and estimates of cost:

Panama. The natural attractions of the Panama route lie in the combination of a very narrow isthmus with a low summit. The width of the isthmus is less than 35 miles in a straight line, while the summit is barely 300 feet above mean tide, which, though higher than the Nicaragua summit, is less than half the

height of any other which has been investigated. The high portion of the isthmus is limited to a width of about 6 miles near the Pacific side, and the Chagres River affords access by canoe navigation to within 15 miles of the Pacific Ocean.

The isthmus here runs nearly east and west, but the course of the railroad or canal is from northwest to southeast, the Pacific terminus being about 20 miles farther east than the Atlantic. The Atlantic port is Colon and the Pacific port Panama. Colon harbor is practically tideless; Panama Bay has a mean tidal range of 20 feet. Neither is a first-class harbor; the defect of Colon harbor is its exposure to strong northerly winds, which, though rare, occur for periods of a few days every year, and while they prevail ships must go to sea for safety; Panama Harbor is a roadstead behind islands at the head of a great bay.

The old Panama Canal Company, organized in 1879, projected a tide-level canal 47 miles in length, between the two oceans. Five miles were in the coastal plain near Colon, twenty-four in the valley of the Chagres, six in the hills which form the divide, seven in the valley of the Rio Grande, a small stream running from the hills into Panama Bay, and five in the harbor approaches. Two principal difficulties were encountered: The line in the valley of the Chagres involved an excavation below the bed of the river, which rises in the mountains east of Panama in a district subject to violent rains and at times floods its entire valley; the passage of the divide in the Culebra region involved an excavation of unprecedented dimensions.

Before the stoppage of work by the old French company the scheme of a tide-level canal was abandoned and various plans for a canal with locks were proposed, the summit level being placed at different heights, the highest being 160 feet above mean tide, to which high level it was proposed to pump the water. The new French company adopted a scheme in which the summit level of the canal is placed at a minimum elevation of 97½ feet, approached by four locks in each direction, to be supplied with water from the upper Chagres, impounded by a dam at Alhajuela and brought through a conduit $10\frac{4}{10}$ miles to the canal at Obispo. By this arrangement the excavation in the continental divide was reduced within such limits that it was thought the work could be finished in eight years. By the construction of a dam across the Chagres at Bohio the river between that point and Obispo was converted into a lake of sufficient dimensions not to be seriously affected by flood discharges, while diversion channels were to be constructed on both sides of the canal from this dam to the sea. With a carefully designed system of sluices and controlling works the violence of the floods was to be checked by impounding the water both above the Alhajuela dam and in Lake Bohio, so as to keep the flow below the Bohio dam within the capacity of the two diversion channels. The adoption of this scheme by the French engineers in preference to a simpler plan, which

was fully discussed by them, was determined by the limits of time to which the company was restricted. As the conditions would be different if the canal were constructed by the United States, the commission has adopted a simpler plan, avoiding complicated constructions like the conduit for the summit supply of water and making the regulation of the floods as nearly as possible automatic.

With the change from the tide-level canal to a canal with locks, a third problem was added to the other two—the supply of water for the summit level. The only available source of supply is the Chagres River. This brings the water supply into such intimate relation with the control of the flood discharge that the two become practically one and must be treated together. The discharge of the Chagres at Bohio varies from a minimum of about 350 to a maximum of over 100,000 cubic feet per second, the extreme flood discharge being about 300 times the low-water discharge. The estimated requirement for the operation of the canal, with an annual traffic of 10,000,000 tons net register, is 1,067 cubic feet per second. The discharge of the Chagres exceeds this in some years for every month, and in all years, except for a short period in February, March, and April, provision must be made for the storage of enough water to supply the deficiency during these three dry months. The best storage place for this water is in the lake formed in the valley of the Chagres, making it of sufficient depth to allow the needed supply to be drawn off without lowering the level enough to impede navigation.

The greatest flood of which there is any record occurred in 1879; from the imperfect information we have it has been estimated that it may have reached a maximum discharge of 75,000 cubic feet per second at Gamboa and 110,000 at Bohio. There is no record of any other flood in which the discharge at Bohio exceeded 80,000 cubic feet per second, while the floods in which it exceeds 50,000 are at such rare intervals that their effect on navigation would not be serious. The works should be so designed that a flood of 70,000 cubic feet per second would produce no currents which would interfere with navigation, the limit of such currents being fixed at 3 feet per second, and that a flood of twice this amount, or a discharge of 140,000 cubic feet per second, while it might temporarily suspend navigation, should not injure the structure of the canal.

No location suitable for a dam exists on the Chagres River below Bohio, and while this location is not without difficulties it has the great advantage that about 3 miles southwest of the dam, near the head of the Rio Gigante, a tributary of the Chagres, there exists an excellent site for a spillway, by which the discharge from the lake could be kept well away from the dam and accessory works. The height of this spillway would regulate the height and area of the lake. After careful consideration the commission has decided to fix this height at

eighty-five feet above mean tide and to make the spillway in the form of a fixed weir two thousand feet long. At elevation eighty-five the lake has an area of thirty-eight and one-half square miles, more than one thousand million square feet. The height of five and one-half feet from the crest of the weir to the elevation required to pass the maximum discharge would represent the impounding of more than six thousand million cubic feet of water. While in the absence of complete data exact calculations can not be made, computations giving reasonably approximate results indicate that no flood has yet occurred which would raise the level of the lake more than a few inches above elevation ninety and five-tenths or create a discharge over the weir exceeding eighty-nine thousand cubic feet per second. The extreme possible effect, however, of a long-continued flood with a discharge of one hundred and forty thousand cubic feet per second, for which there is absolutely no precedent, as all great floods are of short duration, will be to raise the water over the spillway to elevation ninety-two and five-tenths and to produce a current of from five to six feet per second in the narrow parts of the lake. Calculations have been made of the amount of water required to supply the deficiencies in the three dry months. An assumption of a minimum average discharge of six hundred and thirty cubic feet per second for ninety days, which is the record of the driest year, gives an aggregate deficiency of thirty-three hundred and ninety-eight million one hundred thousand cubic feet below the required supply of 1,067 cubic feet per second, which corresponds to a depth of about three feet over the whole area of the lake. Under these extreme conditions the level of the lake might therefore be lowered to elevation 82. This represents a range of 8 feet from elevation 82 to elevation 90 in Lake Bohio during navigation. Any rise above 90 would mean nothing more than a swift current for a limited distance, and any fall below 82 would mean a temporary decrease in the depth of water in the canal.

The overflow of Lake Bohio would discharge through the Gigante spillway into the Peña Blanca Swamp and thence into the Chagres near the point where the Chagres has abandoned its old channel and now flows through the canal excavation made by the old company. It is necessary to construct a new channel of large dimensions west of the canal to take the Chagres; an alternate plan would be to leave the present canal to carry off this water and construct the canal on a new location farther east. A feasible location has been found which, besides keeping the canal safely away from the Chagres, is a mile and a quarter shorter than the original French line. The old location has, however, been retained in these estimates, the canal being enlarged to meet the new dimensions adopted by the Commission. This involves a new channel from the Marias de Peña Blanca to the Marias de Agua Clara and a continuous levee for 5 miles along the line of the canal.

The canal, as thus projected, may be described as follows:

The excavation begins at the 6-fathom line in the harbor of Colon, with a bottom width of 500 feet, and slopes of 1 on 3 through the bay and lowland two and sixty-two hundredths miles, of which about one mile is inside the shore line, forming a narrow protected harbor. The estimated cost of this entrance and harbor is $7,334,673.

From the inner end of the harbor the bottom width of the canal is 150 feet, the side slopes of 1 on 3 being retained for one and ninety-six hundredths miles through the swamp, after which they are reduced to the standard used in firm earth. This level extends twelve and fifty-six hundredths miles to the Bohio locks. Its estimated cost is $10,718,288. At Bohio is located a double flight of locks, having a total lift varying from 82 feet at the minimum level of the lake to 90 feet at the maximum, 45 to each lock; the normal lift being 85 feet. These locks are on the location adopted by the French company. The estimated cost of this flight of double locks, four lock chambers in all, is $10,982,345.

Above the locks the canal enters the artificial lake formed by the Bohio dam and known as Lake Bohio. For the first 7 miles it is a broad, deep body of water, affording room for anchorage as well as navigation. Beyond this some light excavations are necessary. At the upper end the channel would be enlarged to provide for the flood discharge of the Chagres, being given a minimum section of 50,000 square feet. The length of the channel in Lake Bohio is $12\frac{59}{100}$ miles from the locks to the point where it enters the cut through the divide. The estimated cost of this section is $2,786,449.

Near to the entrance to the summit cut would be placed a pair of gates 100 feet wide, so that if it should become necessary to draw off the water from the summit cut the level of Lake Bohio would not be affected. These gates would be at the site of a lock proposed by the French company near Obispo with a foundation on hard rock. The estimated cost of these gates is $295,433.

The summit cut is seven and ninety-five hundredths miles long from the Obispo gates to the Pedro Miguel locks. The highest point is about five miles from the Obispo gates where the bottom of the canal is 274 feet below the natural surface of the ground at the sides of the cutting. This is the famous Culebra cut, though the name has often been applied only to the mile of heaviest work. There is a little very hard rock at the eastern end of this section and the western two miles are in ordinary materials. The remainder consists of a hard indurated clay, with some softer material at the top and some strata and dikes of hard rock; in fixing the price it must be rated as soft rock, but it must be given slopes equivalent to those in earth. This cut has been estimated on the basis of a bottom width of 150 feet with side slopes of one on one. While the cut may not be finished with this uniform

slope, this furnishes as correct a basis of estimate as can now be arrived at. The entire cut would be lined with masonry walls finishing at elevation 92, 2 feet above high water, these walls having nearly vertical faces and furnishing benches 38 feet wide on either side of the canal, on one of which the Panama railroad would be laid, while it is probable that a service track would be placed on the other. Much has been said about the instability of the Culebra cut; in point of fact, there is a clay in the upper portion of the deep cut which flows readily when saturated, but which will give little trouble if thoroughly drained; probably nine-tenths of the material would naturally be classed as hard clay of stable character; it would weather somewhat, and the surface might require some repairing with concrete in bad places, a practice common in deep cuttings in Europe; this clay disintegrates rapidly in water, and for this reason the canal prism should be confined between masonry walls. With the provision made for broad benches on each side, on which any slight slides would be arrested, it is confidently believed that no trouble would be experienced. The estimated cost of the 6.02 miles of heavy work is $41,940,480, and of the entire 7.95 miles between the Obispo gates and the Pedro Miguel locks, $44,378,335. It would probably take eight years to excavate this section of the canal.

The Pedro Miguel locks will be similar to the Bohio locks, the aggregate lift varying from 54 to 62 feet. There is an excellent rock foundation here. The estimated cost of these locks, including an adjacent dam, is $8,496,326.

A level 1.33 miles long extends from the Pedro Miguel locks to the last lock, which is at Miraflores. The normal elevation of the surface of the water is 28. The estimated cost of this section is $1,169,611.

At the end of this level would be located the Miraflores lock, with a lift varying from 18 feet at high tide to 38 feet at mean low tide. There is a good rock foundation for this lock. A spillway will be required to regulate the height of this level. The estimated cost of this lock and spillway is $5,720,363.

For 4.12 miles beyond the Miraflores lock the canal extends through a low swamp country through which the Rio Grande runs. Occasional rock is found here, but the material is generally very soft and the canal has been estimated for a bottom width of 150 feet with slopes of 1 on 3. This brings the canal to a point known as La Boca where the Panama Railroad Company has constructed a large and substantial wharf. A dredged channel 200 feet wide with slopes of 1 on 3 would extend from here 3.6 miles to the 8-fathom line in Panama Bay. The first 2 miles of this dredged channel are through flats which are bare at low water, where there is a considerable amount of submerged rock. The total cost of this section from the lock to deep water is estimated at $12,366,914.

Besides the works embraced in the excavation of the canal itself there will be five outlying works which must be considered. These are the Bohio dam, the Gigante spillway, the diversion of the lower Chagres opposite Gatun, the diversion of the Gatuncillo east of Gatun, and the diversion of the Panama railroad around Lake Bohio.

The Bohio dam is the most important structure on the line. A dam of either earth or masonry is feasible, the latter being the more expensive. The French plan contemplated a dam of earth. It has been decided, however, to use the masonry type for the purpose of these estimates. The foundation must be carried to rock, the depth to which has not yet been ascertained at all points, though the maximum is known to be not less than one hundred and twenty-eight feet below mean tide. The estimated cost of such a dam is $8,500,000.

The Gigante spillway, which is a structure of considerable magnitude, is very simple. There is a good rock foundation at or above tide level for the entire length of this spillway. It would consist of a masonry dam with a crest at elevation eighty-five, terminating in an apron at elevation sixty-five, with a solid foundation below this level, the apron being everywhere below the present surface of the ground. The foundation, below elevation sixty-five, would be put in first and before the flow of water through the present river at the site of the Bohio dam is checked. The water after passing over this spillway would flow across the country about a mile to the swamp known as the Marais de Peña Blanca. The elevation of the surface of this swamp is now 22.3 feet, so that the water would have a fall of 42.7 feet in this mile, which fall would be materially reduced in extreme floods by the backing up of water in the swamp. Plans have been prepared for this spillway, and the estimated cost is $1,124,524.

A channel must be cut from the Marais de Peña Blanca to the Marais de Agua Clara, the cost of which is estimated at $1,448,076.

A channel was cut by the old Canal Company to divert the Chagres from the canal opposite Gatun. This channel, however, is of very inadequate dimensions and a new channel, part of which will be an enlargement of the present one, should be cut here. It should have a cross section of 10,000 square feet. Rock would be encountered in its excavation, and its cost has been estimated at $1,929,976.

A diversion channel intended to take part of the waters of the Chagres was constructed by the old company along the east side of the canal to Boca Grande back of Colon. This cut across the Gatuncillo near Gatun and the portion of it north of this point is available as a new channel for the Gatuncillo. Some work must be done on it, especially at the crossing of the Panama Railroad, where the piers for a new bridge are completed. The cost of putting this channel into service is estimated at $100,000.

From Bohio to the Obispo gates the Panama Railroad must be rebuilt for 15½ miles on an entirely new location, with a bridge across the

Chagres, below Gamboa. An estimate made from approximate profiles indicates that the cost of this diversion will not exceed $75,000 a mile, or $1,162,500. From the Obispo gates the railroad would be carried for 6 miles on the bench formed by the retaining wall on the east side of the Culebra cut, these 6 miles being estimated to cost $10,000 a mile, which includes only track laying, ties, and ballasting. Beyond this will be a mile of light work estimated at $25,000, while the main track will have to be raised for 2 miles farther at a cost of $20,000. Combining these figures, the total cost of the diversion of the Panama Railroad becomes $1,267,500.

Summing up the several figures already given, the total estimated cost of completing the Panama Canal is as follows:

Colon entrance and harbor	$7,334,673
Harbor to Bohio locks, including levee	10,718,288
Bohio locks, including excavation	10,982,345
Lake Bohio	2,786,449
Obispo gates	295,436
Culebra section	44,378,335
Pedro Miguel locks, including excavation and dam	8,496,326
Pedro Miguel level	1,169,611
Miraflores locks, including excavation and spillway	5,720,363
Pacific level	12,366,914
Bohio dam	8,500,000
Gigante spillway	1,124,524
Channel between the marshes	1,448,076
Chagres diversion	1,929,976
Gatuncillo diversion	100,000
Panama railroad diversion	1,267,500
Total	118,618,816
Engineering, police, sanitation, and general contingencies	23,723,763
Aggregate	142,342,579

This estimate is for the completed project. A canal begun upon this plan may be opened to navigation before its final completion. If single instead of double locks be used, and the bottom width be made 100 instead of 150 feet, the cost will be reduced $26,401,364, and the estimate becomes $115,941,215.

Although the French Company for special reasons adopted the plan with a higher summit level, their engineers worked up a plan in which the level of Lake Bohio was carried completely through the Culebra cut, the high-water level being raised to elevation 67. Under this plan the supply of water for the dry months would be obtained from the upper Chagres, the Alhajuela dam being built to impound a sufficient amount. The fluctuation of the water in Lake Bohio could then be reduced to 5 feet, from 62 to 67. The dimensions adopted by this

Commission have been applied to a canal on these lines. The cost of the Alhajuela dam must be added as well as that of a railroad 10 miles long from the Obispo gates to the site of the dam. The estimate for completing the canal by this plan is as follows:

Colon entrance and harbor	$7,334,673
Harbor to Bohio locks, including levee	10,706,217
Bohio locks, including excavation	9,060,960
Lake Bohio	7,285,367
Obispo gates	323,805
Culebra section	53,950,078
Pedro Miguel locks, including excavation and dam	7,906,658
Pedro Miguel level	1,997,318
Miraflores lock, including excavation and spillway	5,070,879
Pacific level	12,366,914
Bohio dam	6,800,000
Gigante spillway	1,408,014
Channel between marshes	868,846
Chagres diversion	1,117,986
Gatuncillo diversion	100,000
Panama railroad diversion	1,267,500
Alhajuela dam	2,000,000
Ten miles of railroad	750,000
Total	130,315,215
Engineering, police, sanitation, and general contingencies	26,063,043
Aggregate	156,378,258

The quantities given in the above estimates are based on the present condition of the isthmus, advantage being taken of various excavations made by the French companies.

The old Panama Canal Company and the Liquidator raised, by the sale of stock and bonds, the sum of $246,706,431.68. The securities issued to raise this money had a par value of $435,559,332.60. There had been excavated about 72,000,000 cubic yards prior to the organization of the new company. Nearly all of the stock of the Panama Railroad had been purchased. The new company has excavated about 5,000,000 cubic yards, making the total amount excavated by the two companies 77,000,000. The amount of this work which will be of value, under the plan recommended by the Commission, has been carefully computed for the main canal line, and is found to be 36,690,649 cubic yards. Adding the excavation in the Gatuncillo diversion, which is estimated at 2,500,000 cubic yards, the quantity of excavation which will be of value in the new plan is 39,190,649 cubic yards. A temporary diversion of the Panama Railroad is also to be considered. Using the same classification of materials, and the same unit prices as

in the other estimates, with the 20 per cent for contingencies, the value of the French work already done becomes:

Canal excavation	$21,020,386
Gatuncillo diversion	1,125,000
Railroad diversion (4 miles)	300,000
	22,445,386
Contingencies, 20 per cent	4,489,077
	26,934,463
Panama Railroad stock at par	7,000,000
Aggregate	33,934,463

The value of the French work is greatly reduced by the fact that the spoil banks on the Atlantic maritime section frequently come within the limits of the enlarged canal now estimated for.

This statement does not include the value of tools, buildings, and other plant, nor of the hospital; nor does it include the value of the maps, drawings, and records, which are unusually complete, for which no accurate estimate can be made. The plant would be a matter of negotiation between its present owners and the contractors for the new work, and so is indirectly included in the cost of the canal as estimated. The offices and hospitals would be a matter of special negotiation, and form part of the sanitation expense provided by the 20 per cent allowance on the new work.

In the letter dated November 18, 1898, addressed to the President of the United States by Mr. J. Bonnardel, president of the board of directors of the Panama Canal Company, it was stated that the company's assets exceeded in value $100,000,000.

Industrial and commercial value.

The use that would be made of an isthmian canal by the United States and other nations, and the effects of that use upon the development of our resources and the extension of our domestic and foreign trade have been carefully investigated, and the commercial advantages derivable from the Nicaragua and Panama routes have been compared in order that every factor having a bearing upon the location of the canal might be considered. In the prosecution of this inquiry data were secured from the official statistics of our own and foreign governments, from commercial organizations and business men who were conferred with personally, and by an extensive correspondence. The final report of the Commission will contain a full discussion of the value of the canal. The following are some of the conclusions to which this investigation has led:

Present tonnage of available traffic.

To determine the amount of tonnage that would use a canal, were it now in existence, two distinct statistical investigations have been made. In one of these the exports and imports of the United States and of the leading

commercial nations of Europe were studied for the purpose of ascertaining how many tons of cargo, or how much freight, those countries would now contribute to the traffic through an American interoceanic canal. The statistics of exports and imports of all countries being given either in values or quantities, it was necessary to convert these into their tonnage equivalents. This change having been made for each commodity, it was found that 3,426,752 cargo tons of the maritime commerce of the United States during the year ending June 30, 1899, could have used the canal to advantage. During the calendar year 1898 the trade of Europe with the west coast of South and Central America and British Columbia amounted to 3,346,377 cargo tons. The sum of these two amounts, 6,773,129 cargo or freight tons, does not include any of the trade between Europe and the Orient, a part of which would have used the American canal had it been in existence. The figures, moreover, apply to the commerce of the past carried on under the conditions then prevailing.

The statistics of entrances and clearances show that the net register tonnage of the American and foreign shipping that would have passed through a canal had it existed during the year 1898–99 was 4,582,128 tons, in addition to a part of the commerce between Europe and the Orient. The opening of the American Isthmian Canal will accentuate the present tendency of traffic to follow round-the-world lines, and not less than one-fourth of the present traffic of Europe with Eastern countries may be expected to use this route. One-fourth of the vessel tonnage employed in the European-Oriental commerce during the calendar year 1898 amounted to 1,154,328 tons net, and this added to 4,582,128 gives a total of 5,736,456, the number of tons of shipping that would have used a canal had it been in existence in 1898–99.

Records of vessel movements, kept by the New Panama Canal Company, show that the commerce between the east and west coasts of the American continent, and between Europe and the American west coast would have caused an isthmian canal to be used by 3,848,577 tons net of shipping in 1899. This sum plus one-fourth of the vessel tonnage of the commerce between Europe and the East gives 5,126,890 tons net register for the traffic available in 1899. The difference between the result of the investigation made by the French company and that conducted by this Commission is 609,566 tons; however, two-fifths of this difference is accounted for by the fact that the French statisticians did not include any tonnage for the trade carried on between the eastern half of the United States and foreign Pacific countries by way of our Pacific ports. The difference between the two totals may also be partly due to their not covering identical periods. The United States statistics of entrances and clearances studied by this Commission were for the fiscal year ending June 30, 1899, whereas the French record of vessel movements was for the calendar year 1899.

The similarity in the results of the two investigations is evidence of the essential accuracy of both.

Probable traffic 1909 and 1914.

The increase during the decade preceding 1899 in the tonnage of the vessels that would have used the canal was 22.55 per cent. Upon the safe assumption that this rate of increase per decade will continue, the available canal tonnage of 1898, as calculated by the French statisticians, will have become 6,127,112 tons in 1908, and 6,922,166, or, in round numbers, 7,000,000 tons net register in 1914; that is, at the end of sixteen years. If the tonnage of the entrances and clearances of the available canal traffic of the year 1898–99, as determined by this Commission's investigation (5,736,456 tons net register), be taken as the basis of estimate, an increase of 22.55 per cent per decade would make the figures for 1909, 7,030,027 tons, and for 1914, 7,782,240 tons net register.

Nicaragua and Panama routes for sailing vessels.

Three-fifths of the seagoing tonnage of the United States now consists of sailing vessels, and we have a larger ocean-sailing tonnage than any other country except the United Kingdom. However, sails are being displaced by steam, and the statistics of steamers and sailing vessels indicate that not more than one-sixth of our total seagoing tonnage will consist of sailing vessels in 1914. If the sailing vessel should continue to give way to the steamer after that date an isthmian canal will not be much used by sailing ships. The unmistakable tendency of commerce is to employ steam instead of sails, not only in the transportation of general or mixed freight, but also for carrying full cargoes of bulky commodities. Moreover, the canal will so increase the competitive advantages of the steamer as to render practically certain its general substitution in place of the sailing vessel for all lines of trade through an isthmian waterway.

Benefits to Europe and United States compared.

As compared with Europe, the United States will derive from the canal far greater benefits, both commercially and industrially. The commerce of Europe with the Pacific coast of North, Central, and South America, under existing conditions, is somewhat larger than the total volume of the present traffic of the United States that may be considered tributary to the canal; but this fact does not indicate the relative advantages which the canal will possess for the trade of Europe and that of the United States. As soon as it has been opened, our trade with the west coast of South America will rapidly increase, as will also the volume of our trade with the Orient. The amount of the American commerce through the canal will quickly surpass the total amount of Europe's traffic.

An isthmian canal will strengthen the unity of the national and political interests of the United States, develop its Pacific territory, and promote the commerce and industries of the entire country. The

benefits which Europe will derive from the canal will be commercial. In addition to this ours will be political and industrial. By bringing the eastern and western sections of our country into closer relations, by reducing the time and cost of transporting our western products to Europe, and by enabling the Eastern, Southern, and Central States to reach the raw materials and markets of Pacific countries cheaply and expeditiously, the canal will more fully identify political and social interests and quicken the industrial activity of every section of the United States. The iron and steel, the textiles, and the other manufactures of the Eastern and Southern States, the coal from the mining regions, the cotton from the South, and the grain and forest products from many sections will flow out to foreign countries in an increasing volume, and this larger trade will be shared generally by the ports of all our seaboards—the Atlantic, the Gulf, and the Pacific. The canal will cause the competition of the United States with Europe in the countries of Western South America and the Orient to be much keener, with the result that the trade of our country will increase more rapidly than will that of our rivals. The canal will aid the United States in securing and maintaining a position of primacy in the international trade of the world.

These are the considerations which justify the expenditure by the United States of the sum required to build the canal. They may involve a low tariff of charges and be at variance with the production of a large revenue from the canal.

Commercial advantages. Nicaragua and Panama routes compared.

(*a*) One method of showing the relative advantages which the Nicaragua and Panama routes would possess is to compare the distances by way of each of them between typical Atlantic and Pacific ports. A few distances are shown in the following table, compiled with the assistance of the United States Hydrographic Office. The table applies only to the routes followed by steamers, and the length of each canal line is reckoned in nautical miles.

Comparison of distances for steamers by the Nicaragua and Panama routes.

From—	To San Francisco.			To Yokohama via Honolulu.		
	Via Nicaragua.	Via Panama.	Saved via Nicaragua.	Via Nicaragua.	Via Panama.	Saved via Nicaragua.
	Miles.	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*
New York	4,922	5,299	377	9,832	10,087	255
Liverpool	7,652	8,038	386	12,562	12,826	264
New Orleans	4,119	4,698	579	9,029	9,486	457

From—	To Shanghai via Honolulu.			To Guayaquil.		
	Via Nicaragua.	Via Panama.	Saved via Nicaragua.	Via Nicaragua.	Via Panama.	Saved via Panama.
	Miles.	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*
New York	10,752	11,007	255	3,247	2,864	383
Liverpool	13,482	13,746	264	5,977	5,603	374
New Orleans	9,949	10,406	457	2,444	2,263	181

Between New York and San Francisco, the Nicaragua Canal route would be 377 nautical miles shorter than the Panama route. Between New Orleans and San Francisco 579 miles would be saved, and, in general, the distances between the Atlantic and Pacific ports of the United States are less by way of Nicaragua.

Between our east coast and Yokohama and Shanghai the Nicaragua route is somewhat shorter, but for the trade of our eastern ports with the west coast of South America the Panama route is not so long as the Nicaragua.

(*b*) A part of the saving in distance effected by using a Nicaragua canal instead of one at Panama would be offset by the longer time of transit at Nicaragua. An average steamer would require twelve hours to make the passage through the Panama Canal, and thirty-three through one across Nicaragua. For a 10-knot steamer this difference of twenty-one hours would be equivalent to 210 knots difference in distance, and for a 13-knot steamer, the difference in time of transit would be equivalent to 273 knots.

(*c*) The Nicaragua route would be the more favorable one for sailing vessels because of the uncertain winds in the bay of Panama. It would not be impossible for sailing vessels to use the Panama Canal, but for average voyages between the two seaboards of the United States, a sailing vessel would require about nine days additional time to make the passage by way of the Panama Canal. However, neither route would be much used by sailing vessels, because of their inability to compete with steamers. They would certainly not be able to compete with steamers, both using the Panama Canal.

(*d*) For the promotion of the domestic trade of the United States, the Nicaragua route would possess advantages over the Panama route, because the distance between our two seaboards is less. For our trade with Japan, China, the Philippines, and Australia, the advantages of the two routes are nearly equal, the distance by way of the Nicaragua route being slightly less. For our trade with South America the Panama route is shorter and more direct.

(*e*) The industrial changes which the Nicaragua Canal would produce in the countries through which it will pass would be great. Nicaragua and Costa Rica comprise a region capable of producing a large amount of tropical products for which there is a demand in Europe and the United States. A canal across their territory would give a great impetus to their economic development.

Rights, privileges, and franchises.

A careful examination has been made of all the rights, privileges, and franchises held and owned by corporations, associations, and individuals at the different canal routes. This necessarily included a study of the treaties relating to the establishment of an interoceanic communication made by the Republics, whose territory is to be occupied, and by the United States, with one another, and also with foreign governments.

The treaties heretofore made exclude all idea of a relinquishment of sovereignty over any of the proposed routes. In most of them the right of transit and the innocent use of the communication, whether by railway or canal, is granted to the other contracting party, its citizens and subjects, to be enjoyed upon equal terms with other governments and people; and the leading commercial nations of the world have committed themselves to the policy of neutrality at the different routes, and some of them have obligated themselves to use their influence to induce other nations to agree to the same policy. No existing treaties between the United States and the Republics of Nicaragua and Costa Rica, or of Colombia, give our Government the right to excavate and operate a maritime canal through any of these countries. The concessions granted by the different Republics through whose territory the lines of the projected canals extend, in terms, exclude the right of the companies holding them to transfer them to any foreign government, and further treaty rights must be acquired to enable the United States to undertake the excavation of a navigable waterway between the two oceans in a governmental capacity.

The only prior obligations to corporations, associations, or individuals in the way of a direct agreement between the United States and Nicaragua authorizing our Government to construct a canal across the territory of the latter, to be under its control, management, and ownership, have been eliminated by the forfeiture and termination of the contracts with the Maritime Canal Company of Nicaragua and the Interoceanic Canal Company. In view of this declaration the Commission has not made any effort to ascertain the cost at which the concessions of these companies can be purchased, for if these forfeitures are final the rights formerly granted to these companies are not in the way of diplomatic negotiations with the Government interested to acquire the consent and authority necessary for the construction of a canal by this route. The situation in Costa Rica is practically the same.

The situation at Panama is different. The Republic of Colombia first granted a concession to the Panama Railroad Company, giving it exclusive privileges on the Isthmus, which will continue according to modifications afterwards made for ninety-nine years from August 16, 1867. A later concession to the Panama Canal Company required it to enter into some amicable arrangement with the railroad company under which the former might occupy the territory along or near its line. The canal company acquired by purchase a majority of the railroad stock and the necessary arrangements were made. This stock is now under the control of the New Panama Canal Company, which gives it a directing influence in both organizations. The canal concession is to continue according to its latest extension for ninety-nine

years from the day on which the canal shall be wholly or partially opened to public service, and the date fixed for this in the contract is October 31, 1910. Should it fail and the concession be forfeited the company will still have exclusive control of the territory through which its line extends till 1966 under the railroad concession.

The canal company is absolutely prohibited to cede or mortgage its rights under any consideration whatever to any nation or foreign government under penalty of forfeiture. The contract with the railroad company contains a like prohibition and declares further that the pain of forfeiture will be incurred by the mere act of attempting to cede or transfer its privilege to a foreign government and such an act is declared absolutely null and of no value or effect.

These concessions, if acquired by the United States, would not give to the Government the control and ownership evidently contemplated by the law, that is an absolute ownership in perpetuity. The right under the contract with the railroad company is designated as "the use and possession" of the property for ninety-nine years and it is provided that "at the expiration of the term of the privilege" and by the sole fact of the expiration, the Government of Colombia shall be substituted in all the rights of the company and shall immediately enter into the enjoyment of the line of communication, its fixtures, dependencies and all its products. The right of the canal company is substantially of the same character. Its concession expressly provides that five years previous to the expiration of the ninety-nine years of "the privileges," the executive power shall appoint a commissioner to examine the condition of the canal and annexes, and make an official report describing the condition of the property in every detail. This report is to establish the condition in which the canal and its dependencies are to be delivered to the National Government on the day of the expiration of the privilege. There is no provision for an extension of either concession, and the entire property in each case passes from the company without compensation.

The privileges granted by these concessions are subject to certain annual charges in the nature of a rental, and to other obligations. The railroad company is bound during the continuance of its concession to pay to the Colombian Government "an annual revenue" of $250,000 in American gold, in quarterly payments. The failure to make any of the quarterly payments, after being one year overdue, subjects the company to a forfeiture of its privilege. It is also bound to transport over its road the Colombian mails without charge, and the troops, chiefs, and officers, and their equipage, ammunition, armament, clothing, and all similar effects belonging to or destined for the service of the Republic, and emigrants to the country up to the number of 2,000 annually. The canal company is bound to pay to the Government in half-yearly installments during the first twenty-five years after the

opening of the canal to the public service, a share amounting to 5 per cent on its gross income from all sources without any deductions whatever. For a second period of twenty-five years the share of the Government is increased to 6 per cent, for a third to 7 per cent, and for a fourth to the termination of its privilege to 8 per cent. The company guarantees that this share shall in no case be less than $250,000 in any year. The Colombian Government also owns, in accordance with the extension law of December 26, 1890, and by the terms of the company's charter, 50,000 full paid shares of its stock, of the par value of 100 francs each, the total number of shares issued by the company being 650,000. The Government of the Republic has the power under the concession to protect these interests by appointing a commissioner or agent to intervene in the collection, and examine the accounts of the company.

An examination of the charter rights of the New Panama Canal Company under the general incorporation laws of France and the special legislation in its behalf resulted in finding an enactment, included in a law passed June 8, 1888, requiring that all the plant necessary for the construction of the canal shall be manufactured in France and that the material must be of French origin.

This being the situation, it was manifest that, even if the privileges of the companies could be purchased by and transferred to the United States, they were encumbered with charges and conditions that would not permit this Government to exercise all the rights of complete ownership over a canal constructed by it at the Panama route.

A new arrangement is necessary if the United States is to undertake such a work. The relinquishment by the canal company, with the consent of Colombia, of the privileges it has under existing concessions, for a consideration to be agreed upon with the United States would leave the way open for treaty negotiations between the two governments to ascertain whether Colombia will consent to the occupation of its territory by the United States for the construction of a canal to be under Government control, management, and ownership, and, if so, whether they can agree upon terms mutually satisfactory. The situation is peculiar, as there are three parties in interest. The United States can enter into no agreement with Colombia that does not have the approval of the company, and the concessions do not permit the company to transfer or attempt to transfer its rights to a foreign government.

The Commission has, however, attempted to ascertain the views of the New Panama Canal Company with reference to a disposition and transfer of its rights. Interviews were had with its president and other officers during the visit to Paris and on several occasions from time to time since then, and on the 10th day of April last a formal letter was addressed to Mr. Maurice Hutin, the president and director-general, asking whether he was in a position to name terms upon

which the company would dispose of its property and interests to the United States. At different times since then the subject has been discussed by the representatives of the company with the Commission and its committee on rights, privileges, and franchises, but no formal reply to the letter was received until this report was being closed. These conferences and correspondence have resulted in no offer to dispose of the property and privileges of the company to the United States upon any terms, even with the consent of the Colombian Government, nor has the company expressed any desire or wish to enter into any negotiations with the United States with reference to such a disposition of its property and rights.

It was proposed by President Hutin that the United States might obtain control of the canal scheme as a majority stockholder of a new organization to which the present company could contribute its concession, plant, unfinished work, and other property, at a valuation to be determined by arbitration, and he expressed the opinion that such an arrangement could be made without violating the concessions. But this must include some plan for the protection of the minority stockholders in the financial management, for they would favor a policy that would realize liberal dividends in proportion to the commercial value of the canal, while the policy of this Government might be to reduce tolls and charges to the cost of maintenance or even below it, if the interests of the people would be thereby advanced.

The plan, however, which the company prefers is that outlined in its letter of February 28, 1899, addressed to the President of the United States, which has been published in Senate Document No. 188, Fifty-sixth Congress, first session, pages 41 and 42.

This was to reincorporate under the laws of New York or some other State, and accord to the United States such representation in its board of directors and such opportunity to acquire an interest in its securities as its concessions permitted. And an assurance was added to the effect that if the United States should desire to perpetuate or enlarge its existing rights and privileges acquired under the treaty of 1846, the company would conform to such supplemental treaty as might be entered into between the United States and Colombia.

The Commission having no other authority than to make investigations and obtain information submits this result of its efforts to ascertain upon what terms the rights and privileges at the Panama route can be obtained. It is proper to add that the examination of the title of the present company to the canal property under the laws of France and Colombia has satisfied this Commission that the New Panama Canal Company has the entire control and management of the canal property. It appears further that the liquidator appointed by the French court to settle the affairs of the old company contributed under the charter all privileges and property of that company to the new organization, and in consideration of this contribution he will be

entitled to receive 60 per cent of the net income after paying all expenses, charges, and stipulated dividends, to be distributed by him among the old stockholders and their representatives. This right to a share in the profits gives no right to the old stockholders to take any part in the acts or administration of the new company, but the charter recognizes a continued interest of the old company in the affairs of its successor, by conferring upon the liquidator, until the completion of the canal, the power to appoint a commission of three members to inspect the progress of the work, the condition and maintenance of the plant and buildings, as well as the accounts relating to these different objects, the expense of the commission to be borne by the new company. It will thus be manifest that if an agreement be made for the purchase of the company's concession and property by the United States, it must include some settlement of this right which the French court has placed under the control of the liquidator.

Comparison of the two routes.

I. The estimated cost of building the Nicaragua Canal is about $58,000,000 more than that of completing the Panama Canal, leaving out the cost of acquiring the latter property. This measures the difference in the magnitude of the obstacles to be overcome in the actual construction of the two canals, and covers all physical considerations such as the greater or less height of dams, the greater or less depth of cuts, the presence or absence of natural harbors, the presence or absence of a railroad, the exemption from or liability to disease, and the amount of work remaining to be done.

The New Panama Canal Company has shown no disposition to sell its property to the United States. Should that company be able and willing to sell, there is reason to believe that the price would not be such as would make the total cost to the United States less than that of the Nicaragua Canal.

II. The Panama Canal, after completion, would be shorter, have fewer locks and less curvature than the Nicaragua Canal. The measure of these advantages is the time required for a vessel to pass through, which is estimated for an average ship at twelve hours for Panama and thirty-three hours for Nicaragua.

On the other hand, the distance from San Francisco to New York is 377 miles, to New Orleans 579 miles, and to Liverpool 386 miles greater via Panama than via Nicaragua. The time required to pass over these distances being greater than the difference in the time of transit through the canals, the Nicaragua line, after completion, would be somewhat the more advantageous of the two to the United States, notwithstanding the greater cost of maintaining the longer canal.

III. The Government of Colombia, in which lies the Panama Canal, has granted an exclusive concession, which still has many years to run. It is not free to grant the necessary rights to the United States, except upon condition that an agreement be reached with the New Panama

Canal Company. The Commission believes that such agreement is impracticable. So far as can be ascertained, the company is not willing to sell its franchise, but it will allow the United States to become the owner of part of its stock. The Commission considers such an arrangement inadmissible.

The Governments of Nicaragua and Costa Rica, on the other hand, are untrammeled by concessions and are free to grant to the United States such privileges as may be mutually agreed upon.

CONCLUSION.

In view of all the facts, and particularly in view of all the difficulties of obtaining the necessary rights, privileges, and franchises on the Panama route, and assuming that Nicaragua and Costa Rica recognize the value of the canal to themselves and are prepared to grant concessions on terms which are reasonable and acceptable to the United States, the Commission is of the opinion that "the most practicable and feasible route for" an isthmian canal to be "under the control, management, and ownership of the United States" is that known as the Nicaragua route.

We have the honor to be, sir, with great respect, your obedient servants,

J. G. WALKER,
Rear-Admiral, United States Navy,
President of the Commission.
SAMUEL PASCO.
ALFRED NOBLE.
GEO. S. MORISON.
PETER C. HAINS,
Colonel, United States Corps of Engineers.
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